Please return or email comments to Aaron by 330pm Tuesday thanks

PERFORMANCE TESTING PROCEDURE- May 6, 2002, AN

Draft

Test Objective- Conduct Alstom HP Turbine Enthalpy Drop Followup Tests. By turbine contract, we are required to test 30 days after startup to determine the amount of degradation (if any) during the first 30 days of operation. Contract penalties and incentives are based upon the average of these two test sets. An outside test contractor will not be onsite with precision instrumentation. We will be using station instrumentation.

To this point, the generator transformer bushing monitoring alarms has prevented us from testing. However, resolution by replacing several of the monitoring system components should be completed this week.

OPERATING PARAMETERS:

Maximum Capacity/ Valves Wide Open Test **IGS UNIT 2**

Test Date and Time: Tuesday, 5/12/2002, 7:00 - 17:00

2 separate tests will be conducted of at least 2 hours duration (1 test in morning & 1 test in the afternoon)

Load, gross	985 MWgross (+/- 10 MW) -highlight
Throttle Pressure	2385 psig
Valve position	Valves Wide Open

Turbine Setup- local control or manual, fixed valve position, AGC- out of service
Boiler Setup- set to control desired throttle pressure. For this test series, the main objective is to achieve Main Steam and Hot Reheat temps, Econ Gas Outlet Temp (EGOT) is secondary for the turbine testing.

It is requested that the night prior to test that furnace wall sootblowing with IRs be minimized to let waterwalls get dirty (so better able to achieve Mn Stm & HRH temps). Prior to the test, set sootblowing so that Main Steam & Hot Reheat temps can be maintain for a minimum of 2 hours. NOTE: No sootblowing for a minimum of 2 hours during each test, due to Cycle Isolation.

Throttle Temperature 1005 F

Main steam sprays will be isolated due to valve leakage problems and spray flow not recognized by the controls system. This was helping to suppress temperatures. Additionally, there was a calibration problem on the controller.

Hot Reheat Temperature 1005 F

Set up boiler to control reheat temps with bias dampers (no reheat sprays)

Generator Power Factor MVAR target of 50 -60, need to supply own MVAR support for Unit 2 auxiliary power, Power Factor needs to be 0.985 lagging to 1.0 (by using the other generator to supply the reactive power required by the station)

IP7010215

Generator Hydrogen Pressure= 63 psi or higher

Water and Steam Cycle Isolation-
Isolate Unit 2 Cold Reheat auxiliary steam supply and route all building heat (if in-service) drains to Unit 1, no air preheat, no polishers in service or polisher regeneration, main steam desuperheating sprays will be isolated, no boiler drum blowdown or cycle makeup during the test.
Feedwater and Steam Systems will require additional valve isolation for the tests.
Turbine Steam Seals- will isolate supply during the test (will be self suppling).
NOTE: will fill condenser hotwell, then isolate condenser makeup and drawoff and monitor the drop in hotwell to calculate cycle steam and water loss rate. Objective is less than 0.1% loss or 7,000 KPPH.

Equipment:
Please have air compressor D running (prior to the test), due to low bus voltage concerns. Do not start during the test series, the air compressor motors are 'small' motors with a 90% voltage start limit on them.

7 pulverizer operation requested
Remove pulverizer primary air flow or coal flow bias, unless absolutely necessary
All cooling tower fans need to be in service.

NOTES:

BOILER CYCLE LIMITATIONS: The maximum steam flow relieving of the boiler relief valve system is **6,900 KPPH.** This is our upper capacity limitation.

BOILER FEED PUMPS: note- BFP 1B has been upgraded and runs with a bias to keep both feed pumps with the same pressure output

PULVERIZERS: at higher loads, losing a second pulv will probably cause a temporary unit derate (unless you have 6 really good mills)

BACKPRESSURE
All cooling tower fans need to be in service to achieve best condenser backpressure..
Due to cool Spring weather conditions, the cooling tower and condenser should be able to handle the heat rejection.

CLOSED CYCLE COOLING WATER TEMPERATURES
There is a concern with increased CCCW temperatures and restrictions caused by the increase in outlet circulating water temperatures. Equipment which needs to be evaluated includes the station air

compressors, vacuum pumps (seal water), booster air compressors and turbine lube oil.

BURNERS/ NOx

Monitor NOx conditions and minimize levels with out of service cooling air and air flow levels.

BAGHOUSE OPERATION

Concern with high baghouse differential pressures (has been rescaled), but this has been addressed with the sonic horn installation. Increased gas flows and removal rates associated with higher operating loads shouldn't pose additional problems or concerns

Monitor ID fan suction pressure over-ride level, has been rescaled.

SCRUBBER OPERATION

Increased gas flows and removal rates associated with higher operating loads shouldn't pose additional problems or concerns with the scrubber module operation. However, monitor scrubber removal rates closely.

ELECTRICAL SYSTEM

While testing the unit at high power output (> 900 MWg) you should be aware of the following limits or constraints of the electrical system.

<u>Generator</u>

The generator is designed for the following rated conditions:

991	MVA	26	kV	22,006	I_A		
0.90	PF	5363	I_F	63	psig H_2		

At loads above 891 MWg the power factor must be raised above 0.90 to stay within the generator capability curve. For testing at 975 MWg the power factor must be above 0.985 lagging. Ideally, the power factor should be set to unity by using the other generator to supply the reactive power required by the station.

In the operating range of 891 to 991 MWg the capacity of the generator is limited by armature heating. All of the generator RTDs and thermocouples should be monitored during the test to verify the temperature of the generator winding stays within design limits. Although you should monitor all of the generator temperature indications , pay particular attention to the following design and alarm limits.

Estimated water outlet temp. (46 C inlet water) at max capability	62 C
High inlet water temperature alarm	48 C (± 1 C)
High water outlet temperature alarm	81 C (± 1 C)
High water outlet temperature trip	86 C (+0/-2 C)
High stator bar outlet temp alarm	86 C (± 1 C)
High stator temp between stator bars	81 C (± 1 C)
High P bar outlet temp	65 C (± 1 C)
Estimated connection ring outlet temp at max capability	55 C
Connection ring outlet temperature alarm	65 C

The temperatures should be monitored using the TGSI system not the PI system.

The generator rating, of 991 MVA, requires a hydrogen gas pressure of 63 psig. For every 1 psi drop in hydrogen gas pressure the generator capability is reduced by 8 MW. At 61 psig, hydrogen gas pressure, the generator must be operated at unity power factor to stay within the generator capability curve, if the generator output is 975 MWg.

Generators are designed to operate continuously at rated kVA, frequency and power factor over a range of 95 to 105% of rated voltage. Operation beyond rated kVA may result in harmful stator over current. Note, at rated kVA, 95% rated voltage, stator current will be 105% . This is permissible. You should carefully monitor the stator current. Do not exceed the rated current of 22,006 amperes unless you calculate the current limit at lower operating voltages (within the ±5% of rated voltage) and you are within those limits. Do not exceed 23,106 amperes for any reason.

Do not operate above the rated kVA of the generator and try to rely on temperature indication to indicate excessive stator currents since unmonitored phenomena such as temperature in other parts of the stator circuit, winding forces, abnormal magnetic field, etc may become excessive.

Operation of the generator with lagging power factor, beyond the limits of the capability curve, may result in overheating the field winding. Increasing the field current will lower the power factor. If you try to lower the power factor (and increase the field current) beyond rated, the maximum excitation limit will activate. The maximum excitation limit is set to 105 % of rated field current (5630 amperes). If this limit is exceeded, an inverse time versus current signal is generated (the higher the current level the shorter the time). After a time delay, the generator will transfer from AC to DC control. If the field current is not reduced below 105%, by the transfer, the generator will trip.

The generator is also protected from under excitation by the underexcited reactive ampere limit. If the AC control system causes operation of the generator to be outside the capability curve (leading power factor region) the URAL control will take over and limit the excitation system. This curve is presently set to not allow leading power factor operation at 975 MWg.

Isophase Bus Duct

The isophase bus is rated for 23,100 amperes at 26 kV. At rated current, the maximum rise, above a 40 C ambient, was designed to be 65 C on the conductor and 40 C on the enclosure. Because our operating experience indicated the bus conductor and enclosure were operating at a higher temperature than design, a forced cooling system was installed on the Unit 2 Isophase Bus in March 2002. Although this cooling system only provides cooling from the generator terminal to the generator circuit breaker the rating for this section of bus is now 24,500 amperes with a 75 C rise on the conductor. The bus is presently configured to handle the maximum output of the generator (23,106 amperes) without any problems as long as the forced cooling system is running.

Generator Step-Up Transformer

The generator step-up transformer is rated at 865 MVA with a 55 C rise and 968.8 MVA with a 65 C rise. Because part of the output of the generator is sent to the auxiliary transformers the generator step-up transformer is not expected to be loaded above nameplate limits. In addition oil filled transformers have an inherent overload capability. The generator step-up transformer temperatures should be monitored during the test. The oil temperature is set to alarm at 91 C and the winding temperatures alarm at 120 C.

EQUIPMENT BID AND RECORD

USE 24HR TIME FORMAT

Requested by Aaron Nissen Div. IPSC Sec. IGS Submitted by ______ Operator ______ Time ______ Date ______

☐ Out of Service
☐ Clearance TO Aaron Nissen/ David Spence/ Garry Christensen (Responsible Party) Div. IPSC Sec. IGS
☒ O.K.

EQUIPMENT REQUESTED: IGS Unit 2 Turbine Performance Test (acceptance test- 30 day followup test) 985 MWgross (+/- 10 MW)/ Valves Wide Open/ 2385 psi throttle press, 1000F throttle temp/ 1000F Hot Reheat/ cycle isolation

NATURE OF WORK: HP Turbine Acceptence Testing, HP & IP turbine enthalpy drop tests, turbine cycle heat rate tests, boiler feedpump and boiler feed pump turbine tests, boiler and balance of plant performance testing.

	FROM	Time	Date	TO	Time	Date
BID Time	Monday	0700 MDST	05/14/02	Friday	1700 MDST	05/14/02
WORK Time	Monday	0700 MDST	05/14/02	Friday	1700 MDST	05/14/02

PREPARATION REQUIRED: Performance Test Conditions- 2 separate tests (1 morning & 1 afternoon) Throttle Press 2385 psi/ VWO / Throttle Temp 1005 F/ Hot Reheat 1005 F/ Backpress (based on ambient conditions), 7 pulverizer operation, all cooling tower fans need to be in service. Set up boiler to control reheat temps with bias dampers (no reheat sprays), setup sootblowing so can maintain MStm & HRH temps for a minimum of 2 hours, minimize furnace sootblowing (let waterwalls get dirty) the night prior to test, main steam temperature control by sprays is ok, isolate unit 2 CRH to aux steam supply and route all building heat (if in service) drains to Unit 1, cycle isolation required, no air preheat, no boiler drum blowdown during the test. Feedwater and Steam Systems requires valve isolation for the tests. Remove unnecessary pulverizer, fan, and BFP biases. NOTE: auxiliary power- have air compressor D I/S prior to test.

BID APPROVED:

OPS Supv. ______ Time ______ Date ______ Removed by ______ Time ______ Date ______

Supt. ______ Time ______ Date ______ Issued to ______ Time ______ Date ______

Dispatcher ______ Time ______ Date ______ Returned by ______ Time ______ Date ______

EQUIPMENT NORMAL: ______ Time ______ Date ______ By ______ Operator ______ Supv.

Remarks: ______

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